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Journal of the Society of Arts.

FRIDAY, AUGUST 28, 1863.

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SOCIETY'S MEMORIAL OF THE PRINCE CONSORT.

NOTICE TO MEMBERS.

In accordance with the Report adopted at the General Meeting held on the 17th ult., additional subscriptions for carrying out the Society's Memorial of His Royal Highness the Prince Consort are invited.

Any member desiring to subscribe, or to increase the amount of his subscription, is requested to send a Cheque or Post-office Order, made payable to Mr. Samuel Thomas Davenport, the Financial Officer.

NOTICE TO INSTITUTIONS.

The Programme for the Examinations for 1864 is now ready, and may be had *gratis*, on application to the Secretary of the Society of Arts.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The Thirty-third Meeting of the British Association for the Advancement of Science commenced, in Newcastle-upon-Tyne, on Wednesday, the 26th of August, 1863, under the direction of the following officers :—

President—Sir William G. Armstrong, C.B., LL.D., F.R.S.

Vice-Presidents—Sir Walter Trevelyan, Bart.; Sir Charles Lyell, LL.D., D.C.L., F.R.S., F.G.S.; Hugh Taylor, Esq.; Isaac Lowthian Bell, Esq.; Nicholas Wood, Esq.; the Rev. Temple Chevallier, B.D., F.R.A.S.; William Fairbairn, Esq., LL.D., F.R.S.

General Secretaries—William Hopkins, Esq., M.A., F.R.S.; John Phillips, Esq., M.A., LL.D., F.R.S., Professor of Geology in the University of Oxford.

Assistant General Secretary—George Griffith, Esq., M.A., Deputy Professor of Experimental Philosophy in the University of Oxford.

General Treasurer—William Spottiswoode, Esq., M.A., F.R.S., F.G.S., F.R.A.S., &c.

Local Secretaries for the Meeting at Newcastle-upon-Tyne—Captain Noble; Augustus H. Hunt, Esq.; R. C. Clapham, Esq.

Local Treasurer for the Meeting at Newcastle-upon-Tyne—Thomas Hodgkin, Esq.

The First General Meeting was held at eight p.m., when the President delivered an address, as follows:—

I esteem it the greatest honour of my life that I am called upon to assume the office of your President. In that capacity, and as representing your body, I may be allowed to advert to the gratifying reception which the British Association met with on their former visit to this region of mining and manufacturing industry, and, as a member of the community which you have again honoured with a visit, I undertake to convey to you the assurance of a renewed and hearty welcome. A quarter of a century has elapsed since the Association assembled in this town, and in no former period of equal duration has so great a progress been made in physical knowledge. In mechanical science, and especially in those branches of it which are concerned in the application of steam power to effect interchange between distant communities, the progress made since 1838 has no parallel in history. The railway system was then in its infancy, and the great problem of trans-Atlantic steam navigation had only received its complete solution in the preceding year. Since that time railways have extended to every continent, and steamships have covered the ocean. These reflections claim our attention on this occasion, because the locality in which we hold our present meeting is the birthplace of railways, and because the coal mines of this district have contributed more largely than any others to supply the motive power by which steam communication by land and water has been established on so gigantic a scale.

The history of railways shows what grand results may have their origin in small beginnings. When coal was first conveyed in this neighbourhood from the pit to the shipping-place on the Tyne, the pack-horse, carrying a burden of 3 cwt., was the only mode of transport employed. As soon as roads suitable for wheeled carriages were formed, carts were introduced, and this first step in mechanical appliance to facilitate transport had the effect of increasing the load which the horse was enabled to convey from 3 cwt. to 17 cwt. The next improvement consisted in laying wooden bars or rails for the wheels of the carts to run upon, and this was followed by the substitution of the four-wheeled wagon for the two-wheeled cart. By this further application of mechanical principles the original horseload of 3 cwt. was augmented to 42 cwt. These were important results, and they were not obtained without the shipwreck of the fortunes of at least one adventurous man whose ideas were in advance of the times in which he lived. We read, in a record published in the year 1649, that "one Master Beaumont, a gentleman of great ingenuity and rare parts, adventured into the mines of Northumberland with his £30,000, and brought with him many rare engines not then known in that shire, and wagons with one horse to carry down coal from the pits to the river, but within a few years he consumed all his money and rode home upon his light horse." The next step in the progress of railways was the attachment of slips of iron to the wooden rails. Then came the iron tramway, consisting of cast-iron bars of an angular section: in this arrangement the upright flange of the bar acted as a guide to keep the wheel on the track. The next advance was an important one, and consisted in transferring the guiding flange from the rail to the wheel: this improvement enabled cast-iron edge rails to be used. Finally, in 1820, after the lapse of about 200 years from the first employment of wooden bars, wrought-iron rails, rolled in long lengths, and of suitable section, were made in this neighbourhood, and eventually superseded all other forms of railway. Thus, the railway system, like all large inventions, has risen to its present importance by a series of steps; and so gradual has been its progress, that Europe finds itself committed to a gauge fortuitously determined by the distance between the wheels of the carts for which wooden rails were originally laid down.

Last of all came the locomotive engine,—that crowning achievement of mechanical science,—which enables us to convey a load of 200 tons at a cost of fuel scarcely exceeding that of the corn and hay which the original pack-horse consumed in conveying its load of 3 cwt. an equal distance.

It was chiefly in this locality that the railway system was thus reared from earliest infancy to full maturity, and amongst the many names associated with its growth, that of George Stephenson stands pre-eminent.

In thus glancing at the history of railways, we may observe how promptly the inventive faculty of man supplies the device which the circumstances of the moment require. No sooner is a road formed fit for wheeled carriages to pass along, than the cart takes the place of the pack-saddle: no sooner is the wooden railway provided than the wagon is substituted for the cart: and no sooner is an iron railway formed, capable of carrying heavy loads, than the locomotive engine is found ready to commence its career. As in the vegetable kingdom fit conditions of soil and climate quickly cause the appearance of suitable plants, so in the intellectual world fitness of time and circumstance promptly calls forth appropriate devices. The seeds of invention exist, as it were, in the air, ready to germinate whenever suitable conditions arise, and no legislative interference is needed to ensure their growth in proper season.

The coal-fields of this district, so intimately connected with the railway system, both in its origin and maintenance, will doubtless receive much attention from the Association at their present meeting.

To persons who contend that all geological phenomena may be attributed to causes identical in nature and degree with those now in operation, the formation of coal must present peculiar difficulty. The rankness of vegetation which must have existed in the carboniferous era, and the uniformity of climate which appears to have prevailed almost from the Poles to the Equator, would seem to imply a higher temperature of the earth's crust, and an atmosphere more laden with humidity and carbonic acid than exist in our day. But whatever may have been the geological conditions affecting the origin of coal, we may regard the deposits of that mineral as vast magazines of power stored up at periods immeasurably distant for our use.

The principle of conservation of force and the relationship now established between heat and motion, enable us to trace back the effects which we now derive from coal to equivalent agencies exercised at the periods of its formation. The philosophical mind of George Stephenson, unaided by theoretical knowledge, rightly saw that coal was the embodiment of power originally derived from the sun. That small pencil of solar radiation which is arrested by our planet, and which constitutes less than the 2000-millionth part of the total energy sent forth from the sun, must be regarded as the power which enabled the plants of the carboniferous period to wrest the carbon they required from the oxygen with which it was combined, and eventually to deposit it as the solid material of coal. In our day, the reunion of that carbon with oxygen restores the energy expended in the former process, and thus we are enabled to utilise the power originally derived from the luminous centre of our planetary system.

But the agency of the sun in originating coal does not stop at this point. In every period of geological history the waters of the ocean have been lifted by the action of the sun and precipitated in rain upon the earth. This has given rise to all those sedimentary actions by which mineral substances have been collected at particular localities, and there deposited in a stratified form with a protecting cover to preserve them for future use. The phase of the earth's existence suitable for the extensive formation of coal appears to have passed away for ever; but the quantity of that invaluable mineral which has been stored up throughout the globe for our benefit, is sufficient (if used discreetly) to serve the purposes of the human race for many thousands of years. In fact, the entire quantity of coal may be considered as practically inexhaustible. Turning, however, to our own particular country, and contemplating the rate at which we are expending those seams of coal which yield the best quality of fuel, and can be worked at the least expense, we shall find much cause for anxiety. The greatness of England much depends upon the superiority of her coal in cheapness and quality over that of other nations; but we have already drawn from our choicest mines a far larger quantity of coal than has been raised in all other parts of the world put together, and the time is not remote when we shall have to encounter the disadvantage of increased cost of working and diminished value of produce.

Estimates have been made at various periods of the time which would be required to produce complete exhaustion of all the accessible coal in the British Islands.

These estimates are extremely discordant; but the discrepancies arise, not from any important disagreement as to the available quantity of coal, but from the enormous difference in the rate of consumption at the various dates when the estimates were made, and also from the different views which have been entertained as to the probable increase of consumption in future years. The quantity of coal yearly worked in the British mines has been almost trebled during the last twenty years, and has probably increased tenfold since the commencement of the present century; but as this increase has taken place pending the introduction of steam navigation and railway transit, and under exceptional conditions of manufacturing development, it would be too much to assume that it will continue to advance with equal rapidity. The statistics collected by Mr. Hunt, of the Mining Record Office, show that at the end of 1861 the quantity of coal raised in the United Kingdom had reached the enormous total of 86 millions of tons, and that the average annual increase of the eight preceding years amounted to 2¾ millions of tons. Let us inquire, then, what will be the duration of our coal-fields if this more moderate rate of increase be maintained.

By combining the known thickness of the various workable seams of coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity comprised in our coal-bearing strata. Assuming 4,000 feet as the greatest depth at which it will ever be possible to carry on mining operations, and rejecting all seams of less than 2 feet in thickness, the entire quantity of available coal existing in these Islands has been calculated to amount to about 80,000 millions of tons, which, at the present rate of consumption, would be exhausted in 930 years, but, with a continued yearly increase of 2¾ millions of tons, would only last 212 years. It is clear that long before complete exhaustion takes place, England will have ceased to be a coal-producing country on an extensive scale. Other nations, and especially the United States of America, which possess coal-fields 37 times more extensive than ours, will then be working more accessible beds at a smaller cost, and will be able to displace the English coal from every market. The question is, not how long our coal will endure before absolute exhaustion is effected, but how long will those particular coal-seams last which yield coal of a quality and at a price to enable this country to maintain her present supremacy in manufacturing industry. So far as this particular district is concerned, it is generally admitted that 200 years will be sufficient to exhaust the principal seams even at the present rate of working. If the production should continue to increase as it is now doing, the duration of those seams will not reach half that period. How the case may stand in other coal-mining districts I have not the means of ascertaining; but as the best and most accessible coal will always be worked in preference to any other, I fear the same rapid exhaustion of our most valuable seams is everywhere taking place. Were we reaping the full advantage of all the coal we burn, no objection could be made to the largeness of the quantity, but we are using it wastefully and extravagantly in all its applications. It is probable that fully one-fourth of the entire quantity of coal raised from our mines is used in the production of heat for motive power; but, much as we are in the habit of admiring the powers of the steam-engine, our present knowledge of the mechanical energy of heat shows that we realise in that engine only a small part of the thermic effect of the fuel. That a pound of coal should, in our best engines, produce an effect equal to raising a weight of a million pounds a foot high, is a result which bears the character of the marvellous, and seems to defy all further improvement. Yet the investigations of recent years have demonstrated the fact that the mechanical energy resident in a pound of coal, and liberated by its combustion, is capable of raising to the same height ten times that weight. But although the power of our most economical steam-engines has reached, or perhaps somewhat exceeded, the limit of a million pounds raised a foot high per lb. of coal, yet, if we take the average effect obtained from steam-engines of the various constructions now in use, we shall not be justified in assuming it at more than one-third of that amount. It follows, therefore, that the average quantity of coal which we expend in realising a given effect by means of the steam-engine is about 30 times greater than would be requisite with an absolutely perfect heat-engine.

The causes which render the application of heat so uneconomic in the steam-engine have been brought to light by the discovery of the dynamical theory of heat; and it now remains for mechanicians, guided by the light they have thus received, to devise improved practical methods of converting the heat of combustion into available power.

Engines in which the motive power is excited by the communication of heat to fluids already existing in the aeriform condition, as in those of Stirling, Ericsson, and Siemens, promise to afford results greatly superior to those obtained from the steam-engine. They are all based upon the principle of employing fuel to generate sensible heat, to the exclusion of latent heat, which is only another name for heat which has taken the form of unprofitable motion amongst the particles of the fluid to which it is applied. They also embrace what is called the regenerative principle —a term which has, with reason, been objected to, as implying a restoration of expanded heat. The so-called "regenerator" is a contrivance for arresting unutilized heat rejected by the engine, and causing it to operate in aid and consequent reduction of fuel.

It is a common observation that before coal is exhausted some other motive agent will be discovered to take its place, and electricity is generally cited as the coming power. Electricity, like heat, may be converted into motion, and both theory and practice have demonstrated that its mechanical application does not involve so much waste of power as takes place in a steam-engine; but whether we use heat or electricity as a motive power, we must equally depend upon chemical affinity as the source of supply. The act of uniting to form a chemical product liberates an energy which assumes the form of heat or electricity, from either of which states it is convertible into mechanical effect. In contemplating, therefore, the application of electricity as a motive power, we must bear in mind that we shall still require to effect chemical combinations, and in so doing to consume materials. But where are we to find materials so economical for this purpose as the coal we derive from the earth and the oxygen we obtain from the air? The latter costs absolutely nothing; and every pound of coal, which in the act of combustion enters into chemical combination, renders more than two and a half pounds of oxygen available for power. We cannot look to water as a practicable source of oxygen, for there it exists in the combined state, requiring expenditure of chemical energy for its separation from hydrogen. It is in the atmosphere alone that it can be found in that free state in which we require it, and there does not appear to me to be the remotest chance, in an economic point of view, of being able to dispense with the oxygen of the air as a source either of thermo-dynamic or electro-dynamic effect. But to use this oxygen we must consume some oxidisable substance, and coal is the cheapest we can procure.

There is another source of motive power to which I am induced to refer, as exhibiting a further instance in which solar influence affords the means of obtaining mechanical effects from inanimate agents. I allude to the power of water descending from heights to which it has been lifted by the evaporative action of the sun. To illustrate the great advantage of collecting water for power in elevated situations, I may refer to the water-works of Greenock, where the collecting reservoirs are situated at an elevation of 512 feet above the river Clyde. The daily yield of these reservoirs is said to be nearly 100,000 tons of water, which is derived from the rainfall on an area of 5,000 acres. The power obtained from this quantity and head of water is equal to that of a steam-engine of about 2,000 horse power, and the whole effect might be realised on the margin of the river, by bringing down the water in a pipe of sufficient capacity, and causing it to act as a column on suitable machinery at the foot of the descent. But the hydraulic capabilities of the Greenock reservoirs sink into insignificance when compared with those of other localities where the naturally collected waters of large areas of surface descend from great elevations in rapid rivers or vertical falls. Alpine regions abound in falls which, with the aid of artificial works to impound the surplus water and equalise the supply, would yield thousands of horse-power; and there is at least one great river in the world which in a single plunge developes sufficient power to carry on all the manufacturing operations of mankind, if concentrated in its neighbourhood. Industrial populations have scarcely yet extended to those regions which afford this profusion of motive power, but we may anticipate the time when these natural falls will be brought into useful operation. In that day the heat of the sun, by raising the water to heights from which to flow in these great rapids and cascades, will become the means of economising the precious stores of motive power, which the solar energy differently directed has accumulated at a remote period of geological history, and which when once expended may probably never be replaced.

I have hitherto spoken of coal only as a source of mechanical power, but it is also extensively used for the kindred purpose of relaxing those cohesive forces which resist our efforts to give new forms and conditions to solid substances. In these applications, which are generally of a metallurgical nature, the same wasteful expenditure of fuel is everywhere observable. In an ordinary furnace employed to fuse or soften any solid substance, it is the excess of the heat of combustion over that of the body heated which alone is rendered available for the purpose intended. The rest of the heat, which in many instances constitutes by far the greater proportion of the whole, is allowed to escape uselessly into the chimney. The combustion also in common furnaces is so imperfect, that clouds of powdered carbon, in the form of smoke, envelope our manufacturing towns, and gases, which ought to be completely oxygenized in the fire, pass into the air with two-thirds of their heating power undeveloped.

Some remedy for this state of things, we may hope, is at hand, in the gas regenerative furnaces recently introduced by Mr. Siemens. In these furnaces the rejected heat is arrested by a so-called "regenerator," as in Stirling's air-engine, and is communicated to the new fuel before it enters the furnace. The fuel, however, is not solid coal, but gas previously evolved from coal. A stream of this gas raised to a high temperature by the rejected heat of combustion is admitted into the furnace, and there meets a stream of atmospheric air also raised to a high temperature by the same agency. In the combination which then ensues, the heat evolved by the combustion is superadded to the heat previously acquired by the gases. Thus, in addition to the advantage of economy, a greater intensity of heat is attained than by the combustion of unheated fuel. In fact, as the heat evolved in the furnace, or so much of it as is not communicated to the bodies exposed to its action, continually returns to augment the effect of the new fuel, there appears to be no limit to the temperature attainable, except the powers of resistance in the materials of which the furnace is composed.

With regard to smoke, which is at once a waste and a nuisance, having myself taken part with Dr. Richardson and Mr. Longridge in a series of experiments made in this neighbourhood in the years 1857-58 for the purpose of testing the practicability of preventing smoke in the combustion of bituminous coal in steam-engine boilers, I can state with perfect confidence that, so far as the raising of steam is concerned, the production of smoke is unnecessary and inexcusable. The experiments to which I refer proved beyond a doubt, that by an easy method of firing, combined with a due admission of air and a proper arrangement of firegrate, not involving any complexity, the emission of smoke might be perfectly avoided, and that the prevention of the smoke increased the economic value of the fuel and the evaporating power of the boiler. As a rule, there is more smoke evolved from the fires of steam-engines than from any others, and it is in these fires that it may be most easily prevented. But in the furnaces used for most manufacturing operations the prevention of smoke is much more difficult, and will probably not be effected until a radical change is made in the system of applying fuel for such operations.

Not less wasteful and extravagant is our mode of employing coal for domestic purposes. It is computed that the consumption of coal in dwelling-houses amounts in this country to a ton per head per annum of the entire population; so that upwards of twenty-nine millions of tons are annually expended in Great Britain alone for domestic use. If any one will consider that one pound of coal applied to a well-constructed steam-engine boiler evaporates 10lbs., or one gallon of water, and if he will compare this effect with the insignificant quantity of water which can be boiled off in steam by a pound of coal consumed in an ordinary kitchen fire, he will be able to appreciate the enormous waste which takes place by the common method of burning coal for culinary purposes. The simplest arrangements to confine the heat and concentrate it upon the operation to be performed would suffice to obviate this reprehensible waste. So also in warming houses we consume in our open fires about five times as much coal as will produce the same heating effect when burnt in a close and properly constructed stove. Without sacrificing the luxury of a visible fire, it would be easy, by attending to the principles of radiation and convection, to render available the greater part of the heat which is now so improvidently discharged into the chimney. These are homely considerations—too much so, perhaps, for an assembly like this; but I trust that an abuse involving a useless expenditure exceeding in amount our income-tax, and capable of being rectified by attention to scientific principles, may not be deemed unworthy of the notice of some of those whom I have the honour of addressing.

The introduction of the Davy lamp was a great event in the history of coal-mining, not as effecting any great diminution of those disastrous accidents which still devastate every colliery district, but as a means of enabling mines to be worked which, from their greater explosive tendencies, would otherwise have been deemed inaccessible. Thus, while the Davy lamp has been of great benefit both to the public and to the proprietors of coal, it has been the means of leading the miners into more perilous workings, and the frequency of accident by explosion has in consequence not been diminished to the extent which was originally expected. The Davy lamp is a beautiful application of a scientific principle to effect a practical purpose, and with fair treatment its efficiency is indisputable; but where Davy lamps are entrusted to hundreds of men, and amongst them to many careless and reckless persons, it is impossible to guard entirely against gross negligence and its disastrous consequences. In coal-mines where the the most perfect system of ventilation prevails, and where proper regulations are, as far as practicable, enforced in regard to the use of Davy lamps, deplorable accidents do occasionally occur, and it is impossible at present to point out what additional precautions would secure immunity from such calamities. The only gleam of amelioration is in the fact that the loss of life in relation to the quantity of coal worked is on the decrease, from which we may infer that it is also on the decrease taken as a percentage on the number of miners employed.

The increase of the earth's temperature as we descend below the surface is a subject which has been discussed at previous meetings of the British Association. It possesses great scientific interest as affecting the computed thickness of the crust which covers the molten mass assumed to constitute the interior portions of the earth, and it is also of great practical importance as determining the depth at which it would be possible to pursue the working of coal and other minerals. The deepest coal mine in this district is the Monkwearmouth Colliery, which reaches a depth of 1,800 feet below the surface of the ground, and nearly as much below the level of the sea. The observed temperature of the strata at this depth agrees pretty closely with what has been ascertained in other localities, and shows that the increase takes place at the rate of 1° Fahr. to about 60 feet of depth. Assuming the temperature of subterranean fusion to be 3,000°, and that the increase of heat at greater depths continues uniform (which, however, is by no means certain), the thickness of the film which separates us from the fiery ocean beneath will be about thirty-four miles—a thickness which may be fairly represented by the skin of a peach taken in relation to the body of the fruit which it covers. The depth of 4,000 feet, which has been assumed as the limit at which coal could be worked, would probably be attended by an increase of heat exceeding the powers of human endurance. In the Monkwearmouth Colliery, which is less than half that depth, the temperature of the air in the workings is about 84° Fahr., which is considered to be nearly as high as is consistent with the great bodily exertion necessary in the operation of mining. The computations therefore of the duration of coal would probably require a considerable reduction in consequence of too great a depth being assumed as practicable.

At the last meeting of the British Association in this town, the importance of establishing an office for mining records was brought under the notice of the Council by Mr. Sopwith, and measures were taken which resulted in the formation of the present Mining Record Office. The British Association may congratulate itself upon having thus been instrumental in establishing an office in which plans of abandoned mines are preserved for the information of those who, at a future period, may be disposed to incur the expense of bringing those mines again into operation. But more than this is required. Many of the inferior seams of coal can be profitably worked only in conjunction with those of superior quality, and they will be entirely lost if neglected until the choicer beds be exhausted. Although coal is private property, its duration is a national question, and Government interference would be justified to enforce such modes of working as the national interests demand. But to enable Government to exercise any supervision and control, a complete mining survey of all our coal-fields should be made, and full plans, sections, and reports lodged at the Mining Record Office for the information of the legislature and of the public in general.

Before dismissing the subject of coal, it may be proper to notice the recent discovery by Berthelot of a new form of carburetted hydrogen possessing twice the illuminating power of ordinary coal-gas. Berthelot succeeded in procuring this gas by passing hydrogen between the carbon electrodes of a powerful battery. Dr. Odling has since shown that the same gas may be produced by mixing carbonic oxide with an equal volume of light carburetted hydrogen, and exposing the mixture in a porcelain tube to an intense heat. Still more recently, Mr. Siemens has detected the same gas in the highly heated regenerators of his furnaces, and there is now every reason to believe that the new gas will become practically available for illuminating purposes. Thus it is that discoveries which in the first instance interest the philosopher only, almost invariably initiate a rapid series of steps leading to results of great practical importance to mankind.

In the course of the preceding observations I have had occasion to speak of the sun as the great source of motive power on our earth, and I must not omit to refer to recent discoveries connected with that most glorious body. Of all the results which science has produced within the last few years, none has been more unexpected than that by which we are enabled to test the materials of which the sun is made, and prove their identity, in part at least, with those of our planet. The spectrum experiments of Bunsen and Kirchhoff have not only shown all this, but they have also corroborated previous conjectures as to the luminous envelope of the sun. I have still to advert to Mr. Nasmyth's remarkable discovery, that the bright surface of the sun is composed of an aggregation of apparently solid forms, shaped like willow-leaves or some well-known forms of Diatomaceæ, and interlacing one another in every direction. The forms are so regular in size and shape as to have led to a suggestion from one of our profoundest philosophers of their being organisms, possibly even partaking of the nature of life, but at all events closely connected with the heating and vivifying influences of the sun. These mysterious objects, which, since Mr. Nasmyth discovered them, have been seen by other observers as well, are computed to be each not less than 1,000 miles in length, and about 100 miles in breadth. The enormous chasms in the sun's photosphere, to which we apply the diminutive term "spots," exhibit the extremities of these leaf-like bodies pointing inwards, and fringing the sides of the cavern far down into the abyss. Sometimes they form a sort of rope or bridge across the chasm, and appear to adhere to one another by lateral attraction. I can imagine nothing more deserving of the scrutiny of observers than these extraordinary forms. The sympathy also which appears to exist between forces operating in the sun and magnetic forces belonging to the earth, merits a continuance of that close attention which it has already received from the British Association, and of labours such as General Sabine has with so much ability and effect devoted to the elucidation of the subject. I may here notice that remarkable phenomenon which was seen by independent observers at two different places on the 1st of September, 1859. A sudden outburst of light, far exceeding the brightness of the sun's surface, was seen to take place, and sweep like a drifting cloud over a portion of the solar face. This was attended with magnetic disturbances of unusual intensity and with exhibitions of aurora of extraordinary brilliancy. The identical instant at which the effusion of light was observed was recorded by an abrupt and strongly marked deflection in the self-registering instruments at Kew. The phenomenon as seen was probably only part of what actually took place, for the magnetic storm in the midst of which it occurred commenced before and continued after the event. If conjecture be allowable in such a case, we may suppose that this remarkable event had some connection with the means by which the sun's heat is renovated. It is a reasonable supposition that the sun was at that time in the act of receiving a more than usual accession of new energy; and the theory which assigns the maintenance of its power to cosmical matter plunging into it with that prodigious velocity which gravitation would impress upon it as it approached to actual contact with the solar orb, would afford an explanation of this sudden exhibition of intensified light in harmony with the knowledge we have attained that arrested motion is represented by equivalent heat. Telescopic observations will probably add new facts to guide our judgment on this subject, and, taken in connexion with observations on terrestrial magnetism, may enlarge and correct our views respecting the nature of heat, light, and electricity. Much as we have yet to learn respecting these agencies, we know sufficient to infer that they cannot be transmitted from the sun to the earth except by communication from particle to particle of intervening matter. Not that I speak of particles in the sense of the atomist. Whatever our views may be of the nature of particles, we must conceive them as centres invested with surrounding forces. We have no evidence, either from our senses or otherwise, of these centres being occupied by solid cores of indivisible incompressible matter essentially distinct from force. Dr. Young has shown that even in so dense a body as water, these nuclei, if they exist at all, must be so small in relation to the intervening spaces, that a hundred men distributed at equal distances over the whole surface of England would represent their relative magnitude and distance. What, then, must be these relative dimensions in highly rarefied matter? But why encumber our conceptions of material forces by this unnecessary imagining of a central molecule? If we retain the forces and reject the molecule, we shall still have every property we can recognise in matter by the use of our senses or by the aid of our reason. Viewed in this light, matter is not merely a thing subject to force, but is itself composed and constituted force.

The dynamical theory of heat is probably the most important discovery of the present century. We now know that each Fahrenheit degree of temperature in a pound of water is equivalent to a weight of 772lbs. lifted 1ft. high, and that these amounts of heat and power are reciprocally convertible into one another. This theory of heat, with its numerical computation, is chiefly due to the labours of Mayer and Joule, though many other names, including those of Thomson and Rankine, are deservedly associated with its development. I speak of this discovery as one of the present age, because it has been established in our time; but if we search back for earlier conceptions of the identity of heat and motion, we shall find (as we always do in such cases) that similar ideas have been held before, though in a clouded and undemonstrated form. In the writings of Lord Bacon we find it stated that heat is to be regarded as motion and nothing else. In dilating upon this subject, that extraordinary man shows that he had grasped the true theory of heat to the utmost extent that was compatible with the state of knowledge existing in his time. Even Aristotle seems to have entertained the idea that motion was to be considered as the foundation not only of heat, but of all manifestations of matter; and, and for aught we know, still earlier thinkers may have held similar views.

The science of gunnery, to which I shall make but slight allusion on this occasion, is intimately connected with the dynamical theory of heat. When gunpowder is exploded in a cannon, the immediate effect of the affinities by which the materials of the powder are caused to enter into new combinations, is to liberate a force which first appears as heat, and then takes the form of mechanical power communicated in part to the shot and in part to the products of explosion which are also propelled from the gun. The mechanical force of the shot is reconverted into heat when the motion is arrested by striking an object, and this heat is divided between the shot and the object struck, in the proportion of the work done or damage inflicted upon each. These considerations recently led me, in conjunction with my friend Capt. Noble, to determine experimentally, by the heat elicited in the shot, the loss of effect due to its crushing when fired against iron plates. Joule's law, and the known velocity of the shot, enabled us to compute the number of dynamical units of heat representing the whole mechanical power in the projectile, and by ascertaining the number of units developed in it by impact, we arrived at the power which took effect upon the shot instead of the plate. These experiments showed an enormous absorption of power to be caused by the yielding nature of the materials of which projectiles are usually formed; but further experiments are required to complete the inquiry.

Whilst speaking of the subject of gunnery, I must pay a passing tribute of praise to that beautiful instrument invented and perfected by Major Navez, of the Belgian Artillery, for determining, by means of electro-magnetism, the velocity of projectiles. This instrument has been of great value in recent investigations, and there are questions affecting projectiles which we can only hope to solve by its assistance. Experiments are still required to clear up several apparently anomalous effects in gunnery, and to determine the conditions most conducive to efficiency, both as regards attack and defence. It is gratifying to see our Government acting in accordance with the enlightened principles of the age by carrying on scientific experiments to arrive at knowledge which, in the arts of war as well as in those of peace, is proverbially recognised as the true source of human power.

Professor Tyndall's recent discoveries respecting the absorption and radiation of heat by vapours and permanent gases constitute important additions to our knowledge. The extreme delicacy of his experiments and the remarkable distinctness of their results render them beautiful examples of physical research. They are of great value as affording further illustrations of the vibratory actions in matter which constitute heat; but it is in connexion with the science of meteorology that they chiefly command our attention. From these experiments we learn that the minute quantity of water suspended as invisible vapour in the atmosphere acts as a warm clothing to the earth. The efficacy of this vapour in arresting heat is, in comparison with that of air, perfectly astounding. Although the atmosphere contains on an average but one particle of aqueous vapour to 200 of air, yet that single particle absorbs 80 times as much heat as the collective 200 particles of air. Remove, says Professor Tyndall, for a single summer night, the aqueous vapour from the air which overspreads this country, and you would assuredly destroy every plant incapable of bearing extreme cold. The warmth of our fields and gardens would pour itself unrequited into space, and the sun would rise upon an island held fast in the grip of frost. Many meteorological phenomena receive a feasible explanation from these investigations, which are probably destined to throw further light upon the functions of our atmosphere.

Few sciences have more practical value than meteorology, and there are few of which we as yet know so little. Nothing would contribute more to the saving of life and property, and to augmenting the general wealth of the world, than the ability to foresee with certainty impending changes of the weather. At present our means of doing so are extremely imperfect, but, such as they are, they have been employed with considerable effect by Admiral Fitzroy in warning mariners of the probable approach of storms. We may hope that so good an object may be effected with more unvarying success when we attain a better knowledge of the causes by which wind and rain, heat and cold, are determined. The balloon explorations conducted with so much intrepidity by Mr. Glaisher, under the auspices of the British Association, may perhaps in some degree assist in enlightening us upon these important subjects. We have learnt from Mr. Glaisher's observations that the decrease of temperature with elevation does not follow the law previously assumed of 1° in 300 feet, and that in fact it follows no definite law at all. Mr. Glaisher appears also to have ascertained the interesting fact that rain is only precipitated when cloud exists in a double layer. Raindrops, he has found, diminish in size with elevation, merging into wet mist and ultimately into dry fog. Mr. Glaisher met with snow for a mile in thickness below rain, which is at variance with our preconceived ideas. He has also rendered good service by testing the efficiency of various instruments at heights which cannot be visited without personal danger.

The facility now given to the transmission of intelligence and the interchange of thought, is one of the most remarkable features of the present age. Cheap and rapid postage to all parts of the world—paper and printing reduced to the lowest possible cost—electric telegraphs between nation and nation, town and town, and now even (thanks to the beautiful inventions of Professor Wheatstone) between house and house—all contribute to aid that commerce of ideas by which wealth and knowledge are augmented. But while so much facility is given to mental communication by new measures and new inventions, the fundamental art of expressing thought by written symbols remains as imperfect now as it has been for centuries past. It seems strange that while we actually possess a system of shorthand by which words can be recorded as rapidly as they can be spoken, we should persist in writing a slow and laborious longhand. It is intelligible that grown-up persons who have acquired the present conventional art of writing should be reluctant to incur the labour of mastering a better system; but there can be no reason why the rising generation should not be instructed in a method of writing more in accordance with the activity of mind which now prevails. Even without going so far as to adopt for ordinary use a complete system of stenography, which it is not easy to acquire, we might greatly abridge the time and labour of writing by the recognition of a few simple signs to express the syllables which are of most frequent occurrence in our language. Our words are in a great measure made up of such syllables as *com*, *con*, *tion*, *ing*, *able*, *ain*, *ent*, *est*, *ance*, &c. These we are now obliged to write out over and over again, as if time and labour expended in what may be termed visual speech were of no importance. Neither has our written character the advantage of distinctness to recommend it: it is only necessary to write such a word as "minimum" or "ammunition" to become aware of the want of sufficient difference between the letters we employ. I refrain from enlarging on this subject, because I conceive that it belongs to social more than to physical science, although the boundary which separates the two is sufficiently indistinct to permit of my alluding to it in the hope of procuring for it the attention which its importance deserves.

Another subject of a social character which demands our consideration is the much-debated question of weights and measures. Whatever difference of opinion there may be as to the comparative merits of decimal and duodecimal division, there can, at all events, be none as to the importance of assimilating the systems of measurement in different countries. Science suffers by the want of uniformity, because valuable observations made in one country are in a great measure lost to another from the labour required to convert a series of quantities into new denominations. International commerce is also impeded by the same cause, which is productive of constant inconvenience and frequent mistake. It is much to be regretted that two standards of measure so nearly alike as the English yard and the French metre should not be made absolutely identical. The metric system has already been adopted by other nations besides France, and is the only one which has any chance of becoming universal. We in England, therefore, have no alternative but to conform with France, if we desire general uniformity. The change might easily be introduced in scientific literature, and in that case it would probably extend itself by degrees amongst the commercial classes without much legislative pressure. Besides the advantage which would thus be gained in regard to uniformity, I am convinced that the adoption of the decimal division of the French scale would be attended with great convenience, both in science and in commerce. I can speak from personal experience of the superiority of decimal measurement in all cases where accuracy is required in mechanical construction. In the Elswick Works, as well as in some other large establishments of the same description, the inch is adopted as the unit, and all fractional parts are expressed in decimals. No difficulty has been experienced in habituating the workmen to the use of this method, and it has greatly contributed to precision of workmanship. The inch, however, is too small a unit, and it would be advantageous to substitute the metre if general concurrence could be obtained. As to our thermometric scale, it was originally founded in error; it is also most inconvenient in division, and ought at once to be abandoned in favour of the Centigrade scale. The recognition of the metric system and of the Centigrade scale by the numerous men of science composing the British Association, would be a most important step towards effecting that universal adoption of the French standards in this country, which sooner or later will inevitably take place; and the Association, in its collective capacity, might take the lead in this good work, by excluding in future all other standards from their published proceedings.

The recent discovery of the source of the Nile by Captains Speke and Grant has solved a problem in geography which has been a subject of speculation from the earliest ages. It is an honour to England that this interesting discovery has been made by two of her sons, and the British Association, which is accustomed to value every addition to knowledge for its own sake, whether or not it be attended with any immediate utility, will at once appreciate the importance of the discovery, and the courage and devotion by which it has been accomplished. The Royal Geographical Society, under the able presidency of Sir Roderick Murchison, was chiefly instrumental in procuring the organisation of the expedition which has resulted in this great achievement, and the success of the Society's labours, in connexion with this and other cases of African exploration, shows how much good may be effected by associations for the promotion of scientific objects.

The science of organic life has of late years been making great and rapid strides, and it is gratifying to observe that researches, both in zoology and botany, are characterised in the present day by great accuracy and elaboration. Investigations patiently conducted, upon true inductive principles, cannot fail eventually to elicit the hidden laws which govern the animated world. Neither is there any lack of bold speculation contemporaneously with this painstaking spirit of inquiry. The remarkable work of Mr. Darwin, promulgating the doctrine of natural selection, has produced a profound sensation. The novelty of this ingenious theory, the eminence of its author, and his masterly treatment of the subject, have perhaps combined to excite more enthusiasm in its favour than is consistent with that dispassionate spirit which it is so necessary to preserve in the pursuit of truth. Mr. Darwin's views have not passed unchallenged, and the arguments both for and against have been urged with great vigour by the supporters and opponents of the theory. Where good reasons can be shown on both sides of a question, the truth is generally to be found between the two extremes. In the present instance we may without difficulty suppose it to have been part of the great scheme of creation that natural selection should be permitted to determine variations amounting even to specific differences where those differences were matters of degree; but when natural selection is adduced as a cause adequate to explain the production of a new organ not provided for in original creation, the hypothesis must appear, to common apprehensions, to be pushed beyond the limits of reasonable conjecture. The Darwinian theory, when fully enunciated, founds the pedigree of living nature upon the most elementary form of vitalised matter. One step further would carry us back, without greater violence to probability, to inorganic rudiments, and then we should be called upon to recognise in ourselves, and in the exquisite elaborations of the animal and vegetable kingdoms, the ultimate results of mere material forces left free to follow their own unguided tendencies. Surely our minds would in that case be more oppressed with a sense of the miraculous, than they now are in attributing the wondrous things around us to the creative hand of a great Presiding Intelligence.

The evidences bearing upon the antiquity of man have been recently produced in a collected and most logically-treated form by Sir Charles Lyell. It seems no longer possible to doubt that the human race has existed on the earth in a barbarian state for a period far exceeding the limit of historical record; but notwithstanding this great antiquity, the proofs still remain unaltered that man is the latest as well as the noblest work of God.

I will not run the risk of wearying this assembly by extending my remarks to other branches of science. In conclusion, I will express a hope that when the time again comes round to receive the British Association in this town, its members will find the interval to have been as fruitful as the corresponding period on which we now look back. The tendency of progress is to quicken progress, because every acquisition in science is so much vantage-ground for fresh attainment. We may expect, therefore, to increase our speed as we struggle forward; but however high we climb in the pursuit of knowledge, we shall still see heights above us, and the more we extend our view, the more conscious we shall be of the immensity which lies beyond.

TWIN SCREW STEAMERS.

It will be remembered that a Paper on this subject was read before the Society last session,[*] by Captain T. E. Symonds, R.N., in which the construction of these vessels was fully described. The *Times*, of Wednesday last, gives the following account of the trial of a vessel, called the *Aurora*, constructed on this principle:—

"The *Aurora* is an iron vessel, 165 ft. in length, with a beam of 23 ft., a depth of 13 ft. 6 in., an area of midship section of 150 square feet, and a displacement of 400 tons. Her engines have a collective nominal power of 120 horse, and drive two three-bladed screws, each independent of the other, 7 ft. in diameter, and with a pitch of 14 ft. 6 in. The cylinders have a diameter of 26 in., and a 21 in. stroke. The *Aurora* is a smart-looking vessel, with much finer lines forward and aft than were possessed by either of her predecessors. She carries two short masts, rigged for fore and aft canvas, and altogether, although "light as a bladder" on the water, has the appearance of a thorough steam "clipper." Her draught of water at starting yesterday was 7 ft. 3 in. aft, and 5 ft. 3 in. forward.

"A large party of gentlemen left town yesterday (Tuesday) morning for Tilbury station pier, along which the *Aurora* lay with her steam up. Immediately on the party embarking the screws were set to work in opposite directions, and the vessel slewed round with her head down river and started on her trial at 12·20 p.m., under the charge of Mr. Leigh, Trinity pilot, the wind being strong at S.W., and the tide half ebb. In running past the measured mile, in the Lower Hope, with the engines not up in their number of revolutions, she was timed and found to go over the ground in 4 min. 8 sec., giving the vessel a speed of 14·516 knots. At 1·30 p.m. the *Aurora* was approaching the Nore Light vessel, the engines averaging 120 revolutions, with 27lb. of steam and a vacuum of 25in., and every part working with the greatest possible smoothness. At 1·37 the Nore was passed, the distance from Tilbury, 20 nautical miles, having been done in 1 hour and 17 minutes, an almost unparalleled rate of speed, considering the vessel's horse-power of engine and hull displacement. From the Nore to the Mouse Light the vessel continued her course, the wind still fresh from the same quarter, and the movement of the water which necessarily accompanied it giving the vessel, from her light draught and hold upon the water, sufficient "roll" to detract from the efficient acting of her only just submerged screws. Notwithstanding this disadvantage, however, she ran past the "mile" on the Maplin Sands in 4 minutes 10 seconds, giving a speed of 14·400 knots, it being now about slack water, and the tide of little moment either way, and accomplished the distance to the Mouse Light at 2h. 5m. 22s., having been 28 minutes and 23 seconds from the Nore—eight nautical miles. During the latter part of the run down, a small jib had been set to steady the vessel, but no other help was given by the vessel's canvas to her engines in attaining this somewhat extraordinary rate of speed. From the Mouse the *Aurora* was run out between the Maplin and the Barrow as far as the Swin Light, passing the *James Dixon*, a fine screw collier under sail and full steam, with her head in the same direction as the *Aurora's* on the way. On reaching the Swin, the vessel's head was brought round and laid homeward, it having been decided not to lengthen the trial by making circles, &c., owing to the high state of the wind, the light condition of the vessel, and the very satisfactory manner in which she had already turned both to port and starboard in answer to her rudder or screws, proving that she possessed the same facilities in that respect as were possessed by the *Flora*, *Hebe*, and *Kate*—a facility of manœuvring, in fact, which must necessarily be possessed by every vessel built for and fitted with double screws driven by independent engines. Southend was passed at 4h. 15m., and about two miles a-head was seen the *Sea Swallow*, one of the fastest paddle steamers on the Thames, plying between London, Southend, and Sheerness, and a hot chase naturally ensued, the *Aurora* eventually passing the clipper at 4h. 40m. in the midst of a heavy squall of wind and rain, and subsequently during the run up to Blackwall passing everything under steam she came across. Gravesend was passed at 5h. 15m., the engines making on the average at the time 127 revolutions, and Blackwall pier, the closing point of the *Aurora's* day's work, being reached in one hour and seven minutes, the distance being 20 miles. At Blackwall the numerous visitors on board disembarked, and returned to town by rail.

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[*] See present Vol. of *Journal*, p. 390.

"Among the visitors on board were Vice-Admiral Sir George Sartorius; Capt. Symonds, R.N. (a strong advocate with the Admiralty for the adoption of the double screw principle in the Royal Navy for some time past); Captain Cuenskaw, the owner of the *Aurora*, destining her for the China trade; Mr. Russell, C.E.; Mr. Allen, R.N., of the *United Service Gazette*; and other gentlemen whose names are well known in the naval, scientific, and literary world.

"The principles of the adaptation of double screws to ships of war has been so far acknowledged in its importance by the Admiralty, that their lordships have given Messrs. Dudgeon an order to construct a small vessel which shall combine in their most efficient form the double-screw principle which they have so spiritedly and successfully brought into public notice."

PREVENTION OF STEAM BOILER EXPLOSIONS.

At the ordinary Monthly Meeting of the Executive Committee of the Manchester Association, on June 30th, 1863, Mr. L. E. Fletcher, chief engineer, presented his Monthly Report, of which the following is an abstract:—

During the past month there have been examined 340 engines—2 specially. 528 boilers—10 specially, 12 internally, 104 thoroughly, and 402 externally, in which the following defects have been found:—Fracture, 8 (2 dangerous); corrosion, 34 (3 dangerous); safety-valves out of order, 9; water-gauges ditto, 21; pressure-gauges, ditto, 9; feed apparatus, ditto, 2; blow-out apparatus, ditto, 35; fusible plugs, ditto, 13; furnaces out of shape, 4 (2 dangerous); over pressure, 2 (both dangerous); blistered plates, 3—total, 140 (9 dangerous). Boilers without glass water-gauges, 8; without pressure-gauges, 2; without blow-out apparatus, 13; without back pressure-valves, 39.

Explosions.

No. 10 Explosion:—The fact of this explosion having occurred, was stated in last month's report, but no detailed particulars had then been received. It has since been ascertained that the boiler was a plain cylindrical egg-ended one, externally fired, and that the explosion was caused by rents commencing at the seams over the furnace, which has so frequently been found to be the case in this class of boiler, and called attention to in these reports. Two other explosions of a very similar character have happened during this month, particulars of which are given.

Nine explosions have occurred during the last month, by which eleven persons have been killed, and twenty-one others injured. One of these explosions, which resulted from collapse of the flue, and by which no injury was done either to persons or surrounding property, occurred to a boiler under the inspection of this Association; while in the eight remaining cases not one of the boilers was under its care. Details will be found below.

The following is the monthly tabular statement:—

Tabular Statement of Explosions from May 23, 1863, to June 26, 1863, inclusive.

Index No.	Date.	General Description of Boiler.	Persons killed.	Persons injured.	Total.
No. 11.	May 29.	Locomotive	1	1	2
No. 12.	" 30.	Cylindrical egg-ended Externally fired ...	5	12	17
No. 13.	June 2.	Upright furnace. Internally fired.........	0	0	0
No. 14.	" 13.	Details not yet ascertained..................	1	5	6
No. 15.	" 13.	Ordinary single flue, or "Cornish." Internally fired	0	0	0
No. 16.	" 14.	Cylindrical egg-ended Externally fired ...	1	0	1
No. 17.	" 15.	Details not yet ascertained	2	3	5
No. 18.	" 15.	Marine	1	0	1
No. 19.	" 26.	Details not yet ascertained	0	0	0
Total			11	21	32

No. 11 Explosion occurred to the boiler of a locomotive engine while running with a passenger train. Between fifty and sixty persons were injured and four killed. This result was not occasioned, however, by the explosion only, but principally by the train running off the line. Whether the engine leaving the rails was the cause or the effect of the explosion, is an interesting question, and one now undergoing strict investigation. All the facts likely to prove of value to steam users generally, which may be elicited with regard to this explosion, will be given to the members of the Association at the earliest opportunity after the close of the inquiry. The only injuries directly attributable to the explosion, are those which happened to the engine-driver and fireman, both of whom were severely scalded, the latter having died in consequence.

No. 12 Explosion, from which five persons were killed and twelve others injured, took place at an ironworks. The boiler in question was not under the care of this Association, was personally examined shortly after the explosion happened, and found to be of cylindrical egg-ended construction, having an internal flue of horseshoe-shape, both the inlet and outlet of which passed through the further end of the boiler, the remainder of the flue being quite independent of the shell, and thus not forming any longitudinal tie from front to back. The boiler was externally fired, the flame first passing underneath the shell, and then entering the flue at one end of the horse-shoe, and escaping to the chimney through the other. The length of the shell was twenty-eight feet, the diameter eight feet six inches, and the thickness of the plate seven-sixteenths, while the blowing-off pressure was about 40 lbs.

The boiler had rent completely into two parts at the fourth transverse seam from the front end, the larger portion of the shell flying forwards in a straight line from its seat, turning a summersault in its course, and landing in a position quite the reverse of its original one; the egg-end pointing to the brick work seating and the open one from it. The smaller portion had flown to a much greater distance than the other, and not, as is usually the case, in a direction immediately opposite, but at right angles to it. A sister boiler working alongside, and connected to the one in question, was moved laterally, sufficiently so to disturb the brickwork seating and break the steam-pipes, though not to unseat it altogether.

With regard to the cause of the explosion :—The boiler was fifteen years old, the plates over the furnace had already been repaired, and it was stated that the seams at that part had been observed to be leaking only a quarter of an hour before the explosion took place ; while, in addition, the shell was found to be patched in several places, and the plates cracked from the rivet holes to the edge. It is concluded, therefore, on consideration of all the circumstances, that the boiler could not have been in good condition, the correctness of which it is thought derives some corroboration from the fact, that the boiler alongside was found at the time of making this examination, to be also leaking at the seams over the furnace, and that considerably, although not under pressure. An examination of the fractures, as well as a consideration of the direction in which the parts had flown, led to the conclusion that the rent had commenced at a longitudinal seam of rivets, extending for some two or three plates over the furnace. The rent ran along as far as this longitudinal seam extended, and when met by a plate crossing it, or "breaking-joint," as it is termed, then developed into a transverse rent, and completely severed the shell in two. It is thought that the fact of this longitudinal rent in the furnace-end of the shell, being situated on one side of the centre, or "keel-line," accounts for that portion having been blown laterally, and that the upward direction which it had evidently taken, had caused the summersault of the remaining and larger portion. The explosion, therefore, is attributed to the imperfect condition of the boiler, and although such defects would not be dangerous in a suitably-constructed double-flued, or "Lancashire" boiler, which is always internally fired, they are generally found to be fatal in those boilers which are fired externally ; while in the present case the effect was aggravated by the fact of the seams of rivets over the fire being in line, and the diameter of the shell being as much as eight feet six inches.

No. 13 Explosion, by which no one was injured or the surrounding property damaged, occurred to a boiler under the inspection of this Association, the particulars of which are as follows :—

The boiler was an upright furnace one, working in connection with two others of similar construction to itself. It was heated by the flames passing off from a furnace employed in preparing heavy forgings ; the flames passing through an internal tube in the centre of the boiler, which ran directly from the top to the bottom. The extreme height of this internal flue was twenty-six feet two inches, but it was not of one diameter throughout. In order to admit of a brickwork lining to guard the flue above water line, the upper part was made of a larger diameter than the remainder, and attached to it by a flanged plate, which formed a "set-off," or shelf, on which the brickwork rested ; again, the lower portion of the tube had a bell-mouth at the bottom, to afford an easy entrance for the flame. The length of the upper part was 11ft. 4in., and the diameter 3ft. 3in. ; the length of the intermediate portion was 10ft. 4in., and the diameter 2ft. 6in. ; while the length of the bell-mouth was 4ft. 6in., and the diameter at the base 3ft., the thickness of the plates being three-eighths of an inch throughout, and the blowing-off pressure 55 lbs.

The explosion, which did not in any way disturb the original position of the boiler, resulted from collapse of the internal flue tube, the collapse being confined to the intermediate portion just described, which it rent at about the middle of its length.

A tube of such small dimensions as those just given, namely, only 10ft. 6in. in length, and 2ft. 6in. in diameter, made of plate three-eighths in thickness, if of good material and workmanship as this one was, would be amply sufficient for a pressure of 55lbs., if working under ordinary circumstances. This would suggest the conclusion that the water supply had been allowed to run short, but no positive indications of the plates having been over-heated appeared upon examination, though this may, however, have taken place on previous occasions without its being known. On account of the height of these upright furnace boilers, the glass gauges became inaccessible, and the one in question was fitted with two gauge taps only, carried down by means of syphon pipes to within reach from the floor. Thus the water could sink below the proper level without affording any external indication, and would consequently pass unknown, should the gauge-taps be neglected. This may have happened without any immediate collapse of the tube taking place, although the flue would be materially weakened by it, and rendered liable to give way some time after in consequence. It is impossible to say whether the flue tube was getting out of shape or not, since the boiler had been in such constant work, that no opportunity was afforded the Association of making an "internal" and "thorough" examination for upwards of three years. This may not, therefore, be an improper time for calling attention to the importance generally, of having spare boilers, so that a suitable opportunity may be afforded for examination, as well as for cleaning and repair. The boiler was found to be heavily incrusted with hard scale, which must considerably have tended to the over-heating and weakening of the flue, to which these vertical boilers are always prone, from the tendency of the ascending steam to cling around the tube and prevent the contact of the water. The inaccessibility of the gauges and fittings of these vertical boilers, on account of their height, is another disadvantage connected with them, and, indeed, a thoroughly good and safe furnace boiler must still be considered as a desideratum.

No. 16 Explosion happened at an ironworks, to an externally-fired boiler 40ft. long, 8ft. in diameter, made of plates seven-sixteenths of an inch thick. The shell of the boiler gave way immediately over the furnace, the fireman being scalded to death from the stream of hot water issuing from the rent. The boiler had been repaired at this part, by putting on a new plate two months previous to explosion, and it was at this plate that the rent occurred.

This boiler, which was not under the charge of this Association, was not personally examined on the occurrence of the explosion, but an engineer who inspected it shortly after, has kindly furnished the following particulars :—The plate ripped open through the solid metal in two places, the rents being about fifteen inches long and one inch wide, while the parts surrounding it were a good deal cracked and the seams patched, so that the bottom of the boiler was evidently in a very defective state. The ruptured plate was about seven-sixteenths of an inch thick, and did not appear of very good quality, as if not thoroughly welded in rolling ; but the fractures were not, properly speaking, "blisters," since the whole thickness of the plate had come down at once. In addition to the inferior character of the plate, the boiler was heavily coated with incrustation, and this had accumulated at the bottom for a depth of three inches just over the fracture, and extended for a space of four feet by two feet. This mud had hardened so much that the water and steam ploughed but a small hole through it in rushing out. There can be little question that this coating of mud had kept the water away from the plate, and thus led to its becoming overheated, from which it gave way. There was plenty of water in the boiler at the time of the rupture.

It will be clear that it is scarcely possible for such a cake of sediment to have formed upon the furnace crown of an internally-fired boiler, and also that an efficient blowing-out apparatus would have prevented the accumulation in a great measure, if not altogether, and thus that the explosion was due to the dangerous character common to all externally-fired boilers, coupled in this case with neglect.

EXAMINATION PAPERS, 1863.

The following are the Examination Papers set in the various subjects at the Society's Final Examinations, held in May last:—

(Continued from page 630.)

ENGLISH HISTORY.

THREE HOURS ALLOWED.

1. Give, with dates, a short life of King Alfred?
2. What were the principal changes introduced into England by the Norman Conquest?
3. State the chief facts in the reigns of John, Henry III., and Edward I., that bear upon the growth of the English Parliament.
4. Explain the respective pretensions of Balliol and Bruce to the crown of Scotland, and state what claim was advanced by Edward I. when he was made umpire?
5. What were the chief causes of the wars of the Roses?
6. Give, with dates, a short outline of Queen Elizabeth's reign.
7. What were the grievances for which the Commons demanded redress in the Petition of Right?
8. Give a short account of the Habeas Corpus Act, and say whether it is to be regarded as a confirmation of old rights, or as a grant of new privileges.
9. On what grounds did our North American colonies rebel against the British Crown, and what were the first incidents of the rebellion?
10. Give a short account of the campaign of Lord Cornwallis in 1781.
11. Give the names of the states that finally established their independence, and notice briefly by whom and when they were settled.
12. Write a short life of the Black Prince, of Sir Walter Raleigh, or of Lord Nelson.
13. Describe the battle of Poictiers, of Towton, or of Edgehill.
14. Enumerate the chief English possessions in 1863.

ENGLISH LITERATURE.

THREE HOURS ALLOWED FOR THE TWO AUTHORS SELECTED BY THE CANDIDATE.

Chaucer.

The Knight's Tale.

I.

(a) Wost though nat well the old clerkes sawe,
That who schal geve a lover eny lawe,
Love is a grettere lawe, by my pan,
Then may be geve to eny earthly man?
Therefore posityf lawe, and such decre,
Is broke away for love in ech degree.

(b) The busy larke, messager of daye,
Salueth in hire song the morwe gray;
And fyry Phebus ryseth up so bright,
That all the orient laugheth of the light,
And with his stremes dryeth in the greves
The silver dropes, hongying on the leeves.

(c) Ther saugh I furst the derk ymaginyng
Of felony, and al the compassyng;
The cruel ire, as reed as eny gleede;
The pikepurs, and eek the pale drede;
The smyler with the knyf under his cloke;
The schipne brennyng with the blake smoke;
The tresoun of the murtheryng in the bed;
The open werres, with woundes al bi-bled;
Contek with bloody knyf, and sharp manace.
Al ful of chirkyng was that sorry place.

(d) The firste moevere of the cause above,
Whan he firste made the fayre cheyne of love,
Gret was theffect, and heigh was his entente;
Wel wist he why, and what thereof he mente;
For with that fayre cheyne of love he bond
The fyr, the water, the eyr, and eek the lond
In certeyn boundes, that they may not flee—

1. State the connexion in which each of the above passages occurs.
2. Turn the first two of them into modern English.
3. Explain the allusions, obsolete words, and peculiar constructions.
4. What words must be pronounced differently from modern usage in order to bring the verse within the laws of metre?

II.

1. From what sources did Chaucer take the story of Palamon and Arcite?
2. Sketch the story very briefly.
3. Give some account of Chaucer's visit to Italy.
4. Name Chaucer's principal works, in prose and verse.
5. Who were the most distinguished of Chaucer's contemporaries?

Shakspere.

Macbeth; Julius Cæsar; As You Like It.

I.

1. [1] He that's coming
Must be provided for: and you shall put
This night's great business into my despatch;
Which shall to all our nights and days to come
Give solely sovereign sway and masterdom.

[2] Then is there mirth in Heaven
When earthly things made even
Atone together.

[3] This tyrant, whose sole name blisters our tongues,
Was once thought honest; you have loved him well;
He hath not touched you yet. I am young, but something
You may deserve of him through me.

[4] A good and virtuous nature may recoil
In an imperial charge.

[5] But, poor old man, thou prun'st a rotten tree,
That cannot so much as a blossom yield,
In lieu of all thy pains and husbandry.

[6] Being unprepared,
Our will became the servant of defect;
Which else should free have wrought.

(a) In what connexion does each of the above passages occur?
(b) Give the sense of each of them in simple prose.
(c) Notice every word which is used in an obsolete or unusual sense, and every peculiar construction.

2. [1] You know that I held Epicurus strong,
And his opinion: now I change my mind,
And partly credit things that do presage.

[2] ——witchcraft celebrates
Pale Hecate's offerings; and withered murther,
Alarum'd by his sentinel, the wolf,
Whose howl's his watch, thus with his stealthy pace,
With Tarquin's ravishing strides towards his design
Moves like a ghost.

(a) In what connexions do the above passages occur?
(b) Explain the allusions.
(c) Notice the peculiar constructions and uses of words.

3. Explain these expressions:—

[1] You'll be whipped for taxation.
[2] You ought not walk.
[3] You are the first that rears your hand.
[4] As lief not be.
[5] It irks me.
[6] Out of suits.

II.

1. Into what classes are the plays of Shakspere divided? To which class does each of the three plays belong?

2. Give some account of the sources from whence the plot of each of these plays was taken. Notice the principal deviations from the original narratives which Shakspere has made in Julius Cæsar and Macbeth.

3. Sketch the third act of Julius Cæsar. Compare the characters of Casca and Cassius.

4. Describe the character of Banquo.

5. Give some account of the early editions of Shakspere's plays.

MILTON.

Paradise Lost; Books I. to VI.

I.

1. Thus they their doubtful consultations dark
Ended, rejoicing in their matchless chief:
As when from mountain tops the dusky clouds
Ascending, while the north wind sleeps, o'erspread
Heaven's cheerful face, the lowring element
Scowls o'er the darkened landskip snow, or shower;
If chance the radiant sun with farewell sweet
Extend his evening beam, the fields revive,
The birds their notes renew, and bleating herds
Attest their joy, that hill and valley rings.

(a) Express the sense of the above passage in simple prose.

(b) Explain all peculiar constructions and words employed in unusual senses.

2. [1] Blind Thamyris and blind Mœonides,
And Tiresias and Phineus, prophets old.
[2] From hence no cloud, or, to obstruct his sight,
Star interposed, however small, he sees,
Not unconform to other shining globes,
Earth and the garden of God, with cedars crowned
Above all hills: as when by night the glass
Of Galileo, less assured, observes
Imagined lands and regions in the moon:
Or pilot, from among the Cyclades
Delos or Samos first appearing, kens
A cloudy spot.
[3] Eden stretched her line
From Auran eastward to the royal towers
Of great Seleucia, built by Grecian kings—
[4] As when to them who sail
Beyond the Cape of Hope, and now are passed
Mozambic, off at sea north-east winds blow
Sabæan odours from the spicy shore
Of Araby the blest.

(a) State the connexion in which each of these passages occurs.

(b) Explain the allusions.

(c) Explain every obscurity arising from peculiar construction, peculiar arrangement, and words employed in unusual senses.

3. Give the meaning of the following expressions:—
Ethereal quintessence.
When Zephyrus on Flora breathes.
Speed succinct.
A boggy Syrtis.
Aurora's fan.
Maia's son.
Anarch—Tartarus—Arreed—Ambrosia.

4. What is to be noticed in the grammar of these passages?

[1] But cloud instead and ever during dark
Surrounds me.
[2] Ten thousand fathom deep.
[3] Than whom none higher sat.
[4] Before the heavens thou wert.
[5] Grinned horrible a ghastly smile.
[6] If thou beest he.

II.

1. To what portions of the Old and New Testaments was Milton most indebted for the outline of Paradise Lost?

2. What references are there in the first six books to the great controversies of Milton's day?

3. Quote some of the passages in which there is allusion made to the poet's personal history.

4. Sketch Milton's early life up to his first marriage. Give a list of his most important prose works.

ADDISON.

The Spectator, Vol. VIII.

I.

1. " To return, therefore, to my first thought, I could not but look upon myself with secret horror as a being that was not worth the smallest regard of one who had so great a work under his care and superintendency."

In what connexion does this passage occur? What are the main lines of thought by which the Spectator and one of his contributors in a later paper, correct the suggestion?

2. " I like the story of the honest Dutchman, who, upon breaking his leg by a fall from the mainmast, told the standers-by it was a great mercy it was not his neck."

What use does the Spectator make of this story?

3. Briefly sketch the story of Fadlallah. To illustrate what truth is it introduced?

4. What is the meaning of the story of Hilpa and Shalum?

5. " It must be owned that fear is a very powerful passion, since it is esteemed one of the greatest of virtues to subdue it."

How does the Spectator carry on this argument?

6. " A grotto so complete, with such design,
What hands, Calypso, could have formed but thine
Each checkered pebble, and each shining shell,
So well proportioned, and disposed so well,
Surprising lustre from thy thought receive,
Assuming beauties more than nature gave.
To her their various shapes and glossy hue,
Their curious symmetry they owe to you.
Not famed Amphion's lute, whose powerful call
Made willing stones dance to the Theban wall,
In more harmonious ranks could make them fall."

(a) In what connexion does this passage occur?
Give the sense of it in plain prose.
Explain the allusions and peculiar expressions.

II.

1. State the circumstances which occasioned the composition of the eighth volume of the Spectator. Name the principal contributors.

2. What are the characteristic qualities of Addison as an essayist?

3. Sketch the life of Addison. Give the titles of his chief works in prose and poetry.

ANGUS.

Handbook of the English Tongue. Chapters I. to VI.

1. From what languages does the English derive its chief elements? In what proportion does each of these languages contribute to our stock of words?

2. State the most important rules for detecting Anglo-Saxon words based on their meanings.

3. How are the English words derived from Latin classified historically? Give examples of each class.

4. What are the principal dialects of the old French language? Give some account of the one of them with which the study of English is most concerned.

5. How are the English words of Keltic origin classified? Give examples of each class.

6. "Etymology is not always a safe guide to the meaning of words." Explain this remark, and illustrate it by examples.

7. Into what periods is the history of the English language usually divided? State some of the characteristic peculiarities of the earlier periods. Name a few authors belonging to each.

8. Classify the Gothic languages.

9. Give the origins of the following words:—Avalanche, Meagre, Lieutenant, Friar, Esquire, Balance, Raisin, Toilette, Usher, Soldier, Tissue, Poison.

10. From what languages are the following words taken? Admiral, Zero, Gong, Amen, Basket, Sofa, Algebra, Scimetar, Mop, Scarlet, Bandit, Lilac, Gravel, Potato, Yacht.

Tennyson.

Idylls of the King.—In Memoriam.

I.

1. [1] O purblind race of miserable men,
How many among us at this very hour
Do forge a life-long trouble for ourselves,
By taking true for false, or false for true;
Here, through the feeble twilight of this world
Groping, how many, until we pass and reach
That other, where we see as we are seen!
[2] But when the Prince had brought his errant eyes
Home from the rock, sideways he let them glance
At Enid, where she droopt: his own false doom,
That shadow of mistrust should never cross
Betwixt them, came upon him, and he sighed;
Then with another humourous ruth remarked
The lusty mowers labouring dinnerless,
And watched the sun blaze on the turning scythe
And after nodded sleepily in the heat.

(a) Give the sense of each of the above passages in simple prose.

(b) Notice every word used in an unusual sense.

2. What is the substance of Enid's song? How is it connected with her character and history?

3. Sketch the story of Elaine.

4. Trace the gradual development of Guinevere's guilt in the notices of her which occur in the first three of the Idylls.

5. Compare the character of King Arthur with that of Geraint.

6. With what purpose is reference made to the raising of Lazarus in In Memoriam?

7. [1] 'Tis better to have loved and lost
Than never to have loved at all.
[2] But for the unquiet heart and brain,
A use in measured language lies;
The sad mechanic exercise,
Like dull narcotics numbing pain.
And what delights can equal those
That stir the spirit's inner deeps,
When one that loves but knows not, reaps
A truth from one that loves and knows?
[4] O last regret, regret can die!
No—mixt with all this mystic frame,
Her deep relations are the same,
But with long use her tears are dry.

(a) In what connexions do these passages occur? Put the thoughts expressed in them into simple prose.

II.

1. What is the meaning of the word Idyll?

2. Give an account of the sources from which the stories of the Idylls are taken.

3. Which do you prefer of the four Idylls? State the grounds of your preference.

4. What series of poems is considered to have a resemblance to In Memoriam, regarded as an expression of human feeling? What are the chief points of likeness and unlikeness which strike you in making the comparison? Do you think that Tennyson's work was suggested by the older one?

5. What facts of personal history can be gathered from In Memoriam which throw light on the occasion of its composition?

6. What are the principal faults which have been found with In Memoriam? In which of these alleged faults does it stand in remarkable contrast to the Idylls? Do you consider that the faults are justly urged? If not, on what grounds do you defend the work.

Pope.

Essay on Man—Essay on Criticism—The Rape of the Lock.

I.

1. [1] Who noble ends by noble means obtains,
Or, failing, smiles in exile or in chains,
Like good Aurelius let him reign, or bleed
Like Socrates, that man is great indeed.
[2] Our school divines this zealous isle o'er spread;
Who knew most sentences, was deepest read:
Faith, gospel, all, seemed made to be disputed,
And none had sense enough to be confuted:
Scotists and Thomists, now in peace remain,
Amidst their kindred cobwebs in Duck-lane.
[3] Close by those meads, for ever crown'd with flowers,
Where Thames with pride surveys his rising towers,
There stands a structure of majestic frame,
Which from the neighbouring Hampton takes its name.
[4] The mighty Stagyrite first left the shore,
Spread all his sails, and durst the deeps explore;
He steer'd securely, and discovered far,
Led by the light of the Mæonian star.
Poets, a race long unconfined and free,
Still fond and proud of savage liberty,
Received his laws; and stood convinced 'twas fit
Who conquered nature should preside o'er wit.

(a) In what connexion does each of the above passages occur?

(b) Express the sense of the second and fourth passages in simple prose.

(c) Explain the allusions.

(d) Notice the peculiarities in the grammar and in the use of particular words.

2. A little learning is a dangerous thing!
Drink deep or taste not the Pierian spring;
There shallow draughts intoxicate the brain,
And drinking largely sobers us again.

(a) What is meant by the Pierian spring?

(b) Do you entirely agree with the poet? Give the reasons of your answer.

II.

1. Give a sketch of the argument of the Essay on Criticism.

2. What do you consider to be the unsound parts of the reasoning in the Essay on Man?

3. What was the incident which occasioned the composition of the Rape of the Lock? Give some account of the source from whence Pope took the machinery of the poem.

4. Sketch the life of Pope. Name some of his most famous contemporaries. Give a list of his principal works.

(*To be continued.*)

Proceedings of Institutions.

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LIVERPOOL INSTITUTE.—The thirty-eighth annual report says that the receipts during the year have amounted to £6,365 3s. 6d., and the payments to £6,333 0s. 10d. On December 31st, the balance in hand was £1,661. The payments include extraordinary expenditure, incurred during the year in connection with the changes which have attended the death of the late head of the day schools, and the appointment of his successor, in altering and improving several of the class rooms, flagging one of the yards, providing new class-books, apparatus, and furniture, and otherwise in aid of the teaching, and to promote the comfort of the pupils. The total number of members, subscribers, and pupils, at the end of the year, was 2,498, being an increase of 20 over the preceding year. The High and Commercial Schools have now been nearly a year under the present head master, the Rev. Mr. Jones, who has fully justified the confidence with which the directors committed these great schools to his charge. The important measures which, before his election, the directors had adopted for improving the education given in the schools, have been carried into effect by him in such manner as to attain the advantages which were hoped for therefrom. The distinguished success of the pupils in the local examinations of Oxford and Cambridge affords gratifying proof of the excellence of the instruction given in the schools, and of their efficient management. Fourteen candidates entered for the Oxford Examination, of whom thirteen passed. Three passed among the seniors —two in the first and one in the second class. Two juniors also passed in the first class, making in all four in the first class; while of all other schools in the kingdom which competed only two obtained as many as four " first classes;" and only one school besides this so many as two " senior first classes." The per-centage of failures in the country was nearly one-half, and in these schools only one out of fourteen. The per-centage of " first classes " taken throughout the country was only eight, and in these schools thirty-one. Greater encouragement has of late been given in the High School to the study of the classics, so far as to secure the advantages they afford in a liberal scheme of modern education, without in any degree diminishing that attention to science and the requirements of a commercial life for which these schools have long been distinguished. The directors have added to the High School a Preparatory Department, which was opened in October. It commenced with eleven pupils, and now contains thirty. Mrs. Holt, the widow of that warm friend and zealous director of the Institute, the late Geo. Holt, Esq., has invested the sum of £1,000 to found a scholarship in the Institute, to be called the " Holt Scholarship." It will be awarded, whenever vacant, to the best boy in the High School. The trustees of the fund will have large powers of varying the application of it, in order to secure that it shall not fail of usefulness hereafter, through too strict limitation. The number of pupils at the close of the year was as follows:—High School, 110; Commercial School, 631; total, 741. The High School now contains 138 pupils, and the Commercial School 643; total, 781, being an increase of 40 over last quarter. The finances of the girls' school are in a most satisfactory state, and its management reflects high credit on Miss Ellison, who is at its head, as well as upon her assistants. The total receipts have amounted to £1,836 16s. 10d., and the payments to £1,713 0s. 8d., showing a surplus of £123 16s. 2d., and increasing the balance to the credit of the school to £1,321 19s. 6d. During the last two years the attendance in the evening school has decreased. This falling off has taken place chiefly in the elementary section of the school, and is doubtless due to causes which leave no room for regret among the friends of popular education. The number of pupils at the close of the year was 430. The sum of £30 has been presented to the directors by the Committee of the Holt Testimonial Fund, accompanied with a suggestion that it should be placed in the hands of trustees, and the interest appropriated to the giving of prizes in the evening school. A course of public lectures on " Political Economy " was delivered in the Institute by the President, J. T. Danson, Esq., early in the year, in accordance with the announcement made at the last annual meeting. Afterwards the President gave weekly class lectures thereon in the evening school, and roused great interest in the subject. The directors have learned with pleasure that he has recently re-opened this class, which is not confined to regular pupils of the evening school, all persons being admissible who desire instruction in the science. The first of the public lectures, having a wide general application, has been published by the directors. The class-book adopted is the " Progressive Lessons in Social Science " of Mr. William Ellis; and of this work the author has, in testimony of the interest with which he watches the experiment, presented to the Institute three dozen copies. During the year the number of students attending the Central School of Art has increased. The usual annual examination was held at the school by her Majesty's Art Inspector, and the following prizes and honours have been awarded to the students, viz:—

National Medallions...	2	Second Grade Prizes...	19
Ditto, Hon. Mention...	1	Ditto, Passes............	55
Local Medals............	22	First Grade Prizes......	92
Ditto, Hon. Mention...	3	Ditto, Passes............	116
Prize Studentships......	7		
		Total	310

being an increase of 124 over the preceding year. Works executed by two of the students of this school, viz., Miss Pow and Mr. Birkmyer (now the master of the Exeter School of Art), were placed by the Science and Art Department in the International Exhibition, to illustrate, in its highest results, the instruction in applied art given in the Government Schools of Art of this country. It is gratifying to the directors to report a considerable increase of the number of students at the Queen's College. The number in attendance at the close of the year was 180, showing an increase of 50 per cent. A provincial matriculation examination of the University of London was again held at the College in July, under the Rev. Professor Newth, M.A., the delegate appointed by the University. The want of additional accommodation led the directors to inquire into the present utility of the museum. They found that it no longer serves any educational purpose which will not be better served by distributing the more useful specimens in the class rooms where the subjects they illustrate are taught; and, satisfied that there no longer exist good reasons for the maintenance of the museum as hitherto, they have resolved to convert the space it occupies into class rooms.

PATENT LAW AMENDMENT ACT.

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APPLICATIONS FOR PATENTS AND PROTECTION ALLOWED.

[*From Gazette, August* 21*st*, 1863.]

Dated 16*th July*, 1863.

1778. H. Mège, 4, South-street, Finsbury—Certain imp. in the mode of treating fatty bodies.

Dated 21*st July*, 1863.

1821. C. H. Roeckner, Richmond-terrace, Clapham-road—Imp. in machinery and process for reducing wood to a fibrous condition for the manufacture of paper stuff or pulp.

Dated 30*th July*, 1863.

1884. J. W. Branford, March, Cambridgeshire—An improved agricultural implement for hoeing and cleaning the land, and for cutting or setting out the plants of root crops at certain distances from each other.

1889. G. Smith, jun., 230, King's-road, Chelsea—Imp. in buffing and traction apparatus of railway carriages and waggons.

Dated 31*st July*, 1863.

1897. B. Johnson, Church-street, Camberwell-green—Imp. in pianofortes.

1899. A. R. Arrott, Saint Helen's, Lancashire—Imp. in bleaching certain vegetable fibres used for textile or other purposes, whether in the raw state or manufactured.

Dated 1*st August*, 1863.

1907. T. Bradshaw, Bolton, Lancashire—Certain imp. in machinery or apparatus for giving motion to "Dobby horses," flying and swinging boats, or similar apparatus used for public amusement.

1908. R. E. Bibby, Manchester—An improved fire proof cement which may be employed for covering walls, ceilings, and floors, and is also applicable in the manufacture of fire bricks, crucibles, retorts, melting pots, and for other purposes where fire-resisting properties are required.

Dated 3*rd August*, 1863.

1914. B. W. Gerland, Macclesfield—Imp. in the manufacture of size, glue, and phosphates.

1915. J. I. P. Bonnet and J. Pfister, 7, Rue Thévenot, Paris—Imp. in lamps.

Dated 4*th August*, 1863.

1923. J. H. Walsh, Kensington—Imp. in breech-loading fire-arms, and in the means of extracting cartridge cases therefrom.

Dated 5*th August*, 1863.

1928. E. A. Cowper, 35A, Great George-street, Westminster—Imp. in furnaces for heating air, steam, and other elastic fluids.

1930. G. Wilkins, Birmingham—An improved means of railway signalling.

1933. W. Hodson, Hull—Imp. in machinery used for propelling carriages and vessels.

Dated 6*th August*, 1863.

1935. G. Gowland, Liverpool—Imp. in mariners' compasses.

1936. C. Lowe, Bradford-street, South Bradford, near Manchester—Imp. in dyeing and printing.

1939. W. P. Hodgson, Hylton, near Sunderland, and J. V. Woodifield, Hope-street Foundry, Sunderland—Imp. in machinery for the manufacture of rivets.

1941. J. Young, Bucklersbury—Imp. in the preservation of animal matter.

1944. G. E. Charageat, 89, Chancery-lane—Imp. in the construction of frames for umbrellas and parasols.

1945. E. E. Quelle, Bermondsey—Imp. in inkstands.

Dated 7*th August*, 1863.

1949. W. Jones, Warrington, Lancashire—Certain imp. in steam boilers.

1951. A. V. Newton, 66, Chancery-lane—An imp. in the manufacture of shuttles. (A com.)

1952. J. W. Slater, Huddersfield—Imp. in the production of yellow and orange colouring matters.

1953. J. H. Johnson, 47, Lincoln's-inn-fields—Imp. in apparatus for preventing sea sickness. (A com.)

1954. R. A. Brooman, 166, Fleet-street—Imp. in coke ovens. (A com.)

1955. E. Watson, King-street—An improved apparatus whereby screw propellers may be made to steer as well as propel, applicable also as an improved ball and socket joint.

1956. J. Platt, 10, Charlotte-street, Bloomsbury—Imp. in apparatus for supplying steam boilers with water.

1957. T. W. Guillod, 15, Park-place-terrace, Paddington—Imp. in the manufacture of chess boards and chess men.

1958. E. Morewood, Stratford, Essex—Imp. in coating metals.

1959. J. Thompson, E. G. Fitton, and F. A. Fitton, Ardwick, Lancashire—Imp. in engines for carding cotton and other fibrous materials.

Dated 8*th August*, 1863.

1960. N. Jarvie and W. Miller, Glasgow—Imp. in the manufacture of oakum, and in apparatus therefor.

1961. W. B. Robins, Harborne, Staffordshire—A new or improved instrument or apparatus for extinguishing fires.

1962. J. Thornton, J. Thornton, A. Thornton, and W. Thornton, Nottingham—Imp. in apparatus used for producing looped fabrics.

1963. A. P. Price, 47, Lincoln's-inn-fields—Imp. in the application of india-rubber and gutta-percha to the manufacture of brushes and mats. (A com.)

1964. H. R. Brown, Cranbourne-street—New or improved apparatus for the regulated delivery of cards, tickets, labels, bills, and sheets or pieces of cardboard, paper, metal, or other material for advertising or other purposes.

1965. M. Smith, 71, Fleet-street—Imp. in obtaining farinaceous material from potatoes.

1966. J. W. Armstrong, Carmarthen—Imp. in fastening and in securing in position the rails of railways, the said fastening being applicable for other uses.

Dated 10*th August*, 1863.

1969. B. Heyne, jun., Chester—Improved apparatus to facilitate sketching and drawing landscapes, buildings, machinery, and other objects in correct perspective.

1970. R. Dickson, London-wall—Imp. in lithographic printing presses.

1972. A. V. Newton, 66, Chancery-lane—An improved manufacture of blue and of violet colouring matter. (A com.)

Dated 11*th August*, 1863.

1973. J. Robson, jun., South Shields—Imp. in money tills.

1974. E. S. Simon, 10, Bury-street—An improved fastening for leggings.

1976. W. Knowles and R. Halliwell, Bolton, Lancashire—Certain imp. in machinery for preparing, spinning, and doubling cotton and other fibrous substances.

1977. D. W. Barker, Anderlecht, near Brussels—Imp. in means o apparatus for actuating rotary shuttle boxes.

1978. J. T. King, Liverpool—Imp. in apparatus for containing and distributing gas for lighting railway carriages, steam boats, and other moveable vehicles and vessels, railway stations, and other places, parts of such apparatus being suitable for governing the supply of gas and air for various purposes.

1979. W. B. Haigh, Oldham—An improved equilibrium saw frame.

1980. A. V. Newton, 66, Chancery-lane—An improved process for hardening cast iron. (A com.)

1981. J. G. Willans, Westbourne-grove-terrace—Imp. in the manufacture of iron.

1982. W. Clark, 53, Chancery-lane—Imp. in road sweeping machines. (A com.)

1983. J. Wheeler, 23, Poultry—Imp. in the perfuming of gloves.

1984. W. Gray, Brownrigg, Haddington, N.B.—Imp. in certain parts of reaping machines, and in the working or application of the same.

1985. Sir J. S. Lillie, 105, Pall-mall—An improved revolving battery.

Dated 12*th August*, 1863.

1986. G. Graham, Dumbarton, N.B.—Imp. relating to baths or boilers used in dyeing.

1987. R. Mushet, Coleford—An imp. or imps. in the manufacture of cast steel.

1988. J. Cornforth and A. Andrews, Birmingham—Imp. in the nails commonly called screw rivets, which improvements are also applicable to other nails and spikes.

1990. R. Canham, Clerkenwell—Imp. in machines for the preparation of moulds for casting.

1991. J. Templeman, Glasgow—Imp. in the manufacture or production of artificial fuel.

1992. R. S. Newall, Gateshead—An improved mode of and apparatus for drying chemical compounds and other substances.

1994. W. Hudson, C. Catlow, and J. Dodgeon, Burnley, Lancashire—Imp. in looms for weaving.

1996. W. Clark, 53, Chancery-lane—An improved lamp for burning coal oil and other similar hydro-carbons without the aid of a draught chimney. (A com.)

Inventions with Complete Specifications Filed.

2009. S. R. Wilmot, Exeter—Imp. in hand trucks. (A com.)—14th August, 1863.

2020. P. F. L. B. Hirn, Le Cateau (Nord), France—A waterproof preparation to make fabrics, thread, textile matters, and others impenetrable against water.—15th August, 1863.

Patents Sealed.

[*From Gazette, August* 21*st*, 1863.]

21*st August.*

471. C. Malpas.
473. H. Kilshaw and T. Elce, jun.
474. F. J. Manceaux.
475. E. T. Hughes.
488. R. A. Brooman.
490. J. D. Welch and A. P. Welch.
491. R. Martindale.
492. T. R. Harding.
493. T. Dickins, A. L. Dickins, and H. Heywood.
494. J. Tatham.
498. W. Whitehead, H. Whitehead, and H. Barber.
500. J. Hawthorn.
503. J. W. Burton.
505. W. Hooper.
507. E. R. Walker.
510. A. Junger.
519. R. A. Brooman.
524. B. Lawrence and W. Niblett.
527. H. H. Henson.
531. N. Thompson.
533. A. Macivor.
534. G. Tomkins.
537. C. Ritchie.
539. W. A. Wilson and J. Smith.
541. A. P. Price.
542. J. Yates.
547. R. J. Nodder.
549. J. H. Albinson and H. H. Cocker.
550. W. Staufen.
552. E. T. Hughes.
553. J. Carver.
554. J. A. Coffey.
557. A. Dudgeon, G. F. L. Meakin, and E. E. Allen.
560. V. D. Delahaye.
564. W. Hadfield.
568. S. Williamson.
570. E. Paine.
571. T. E. Symonds.
574. E. Hayes.
575. S. Bateman.
585. J. S. Wells.
593. J. Henderson.
599. B. S. Cohen.
611. W. Clark.
617. J. Clinton.
639. D. W. Ransom.
661. A. Barclay.
669. A. Barclay.
694. J. Tangye.
797. J. Norton.
886. T. Gray.
1252. F. Fenton.
1409. A. J. Hollingsworth.

Patents on which the Stamp Duty of £50 has been Paid.

[*From Gazette, August* 25*th*, 1863.]

18*th August.*

2016. M. Jacoby.

19*th August.*

2033. J. H. C. Lacroisade.
2039. S. Greenwood.

20*th August.*

2038. A. Halter and F. Decorce.
2053. A. V. Newton.

21*st August.*

2051. J. Wilkes, T. Wilkes, and G. Wilkes.
2144. G. Bedson.
2228. P. Pautard.

22*nd August.*

2043. F. P. J. Van den Ouwelant.

Patents on which the Stamp Duty of £100 has been Paid.

[*From Gazette, August* 25*th*, 1863.]

17*th August.*

1952. J. Crossley.

22*nd August.*

2046. E. P. Spiller.